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HYBRID POPLAR PLANTING IN THE LAKE STATES

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Poplars are among our fastest growing trees. Many of them are also relatively easy to grow from cuttings and to hybridize by means of cut flower-bearing twigs. Their wood is in demand for pulpwood, veneer for match and crate production, boxboards, and other uses. For these reasons there has been interest in many countries in selecting and breeding poplars. The tree breeder's goal has been the development of a tree which will produce large volumes of suitable wood on short rotations.

Hybrid poplars have been recognized for over 100 years, but it is only within the past 20 years that artificial crosses have been extensively made. Over 170 hybrid poplars, both natural and artificial, are now known (2, 3). The majority have been developed in the United States. However, artificial poplar hybrids have also been produced in Canada, Sweden, Germany, Russia, Italy, and Holland (1, 5).

In the United States, most of the poplar hybrids were developed after 1924 by the Oxford Paper Company of Rumford, Maine, in cooperation with the New York Botanical Garden (6), in a search for new poplars valuable for pulpwood production. Some 13,000 hybrid seedlings were obtained from 99 different cross combinations between 34 different species, varieties, and hybrids of poplars (6). After some trials in the field, cuttings of the most promising of these new hybrids were sent to various localities for field testing. The Lake States Forest Experiment Station and some other agencies in this region received such stock and tested it.

FIELD TESTS BY THE STATION

Hybrid poplar cuttings, largely those originated by the Oxford Paper Company project, were planted by the Station in several localities in Michigan, Wisconsin, Minnesota, and North Dakota.

Minnesota Tests

1935 Planting

In the spring of 1935, cuttings of 10 hybrid poplars purchased from the Oxford Paper Company were planted in two field plots on the Chippewa National Forest near Cass Lake. One plot (No. 95) was on a sandy soil and one (No. 94) on a silt-loam soil. These clones were designated by the following numbers: 33-2, 33-9, 58-3, 77-2, 96-14, 97-19, 97-28, 97-49, 105-1, and 155-9 (table 1). Both

1/ Maintained at University Farm, St. Paul, Minnesota, in cooperation with the University of Minnesota.

Table 1.--Parentage of poplar hybrids tested in Lake States

Cross	Designation	Parentage		Genus group[1/]		Common name
		Female parent	Male parent	Female parent	Male parent	
1	OP 1,2,3,4,5,6,7,8, 33-2, 33-9, 58-3	Populus nigra	P. laurifolia	3	5	Rumford poplar Strathglass poplar Frye poplar
2	OP 9, 10, 11	do.	P. trichocarpa	3	5	Roxbury poplar
3	Carolina poplar	do.	P. deltoides var. missouriensis	3	5	Carolina poplar
4	OP 12	P. nigra betulifolia	P. trichocarpa	3	5	Andover poplar
5	.....	P. nigra baatanicorum vitrum	P. trichocarpa	3	5	
6	.....	P. nigra italica	xP. canadensis	3	3	
7	OP 14, 16	xP. charkowiensis	P. balsamifera virginiana	3	3	
8	OP 18, 19, 21	do.	P. caudina	3	3	
9	OP 24	do.	P. nigra plantierensis	3	3	
10	OP 27	do.	xP. berolinensis	3	5	
11	OP 28, 29; 155-9	do.	P. trichocarpa	3	5	
12	OP 31	do.	Unidentified cottonwood	3	3	
13	39-9, 77-2	do.	xP. Eugenei clone	3	3	
14	OP 32, 33; 105-1	P. angulata	xP. berolinensis	3	5	
15	OP 34	do.	P. incrassata	3	3	
16	xP. generosa	do.	P. trichocarpa	3	5	(Henry) poplar
17	OP 35	do.	P. nigra plantierensis	3	3	
18	OP 37, 38	P. sargenti	xP. berolinensis rossica	3	5	
19	. . . . .	do.	P. deltoides	3	5	
20	OP 39	xP. petrowskyana	P. caudina	5	3	
21	OP 41, 42; 96-14 97-19, 97-28, 97-49	P. maximowiczi	P. trichocarpa	5	5	Androscoggin poplar
22	OP 44, 45, 46, 47, 48 49, 50	do.	xP. berolinensis	5	5	Geneva poplar; Oxford popla
23	OP 51,52	do.	P. nigra plantierensis	5	3	Rochester poplar

(continued)

Table 1.--Parentage of poplar hybrids tested in Lake States (continued)

Cross	Designation	Parentage		Genus group 1/		Common name
		Female parent	Male parent	Female parent	Male parent	
24	.....	P. maximowiczi	P. balsamifera virginiana	5	3	
25	.....	do.	P. caudina	5	3	
26	OP 54, 55	P. tacamahaca candicans	xP. berolinensis	5	5	Maine poplar
27	OP 56	xP. rasumowskyana	P. caudina	5	3	
28	.....	do.	P. incrassata	5	3	
29	.....	P. balsamifera virginiana	xP. berolinensis	3	5	
30	.....	P. deltoides	P. nigra	5	3	
31	.....	do.	xP. canadensis	5	3	

1/ The genus Populus is divided by botanists into several groups or sections which may be called: (1) the white poplars, (2) the aspens, (3) the black poplars and cottonwoods, (4) the large-leaved poplars and cottonwoods, (5) the balsam poplars, and (6) the variable-leaved poplars.

plots were cultivated during the first two years. All hybrids failed by the end of two years on the light soil. Those on the heavier soil did much better. Although only two (105-1 and 77-2) of the original ten were retained after five years. The rest had been eliminated because of poor growth and form, largely as a result of freezing injury in the fall before the shoots had hardened. The average height of those individuals escaping frost injury ranged from 6 to 9 feet after four growing seasons.

Cuttings of the three best lots (105-1, 77-2, 97-19) were planted in 1940 in an arboretum on a good silt loam which had been cleared of a good stand of aspen. Although they grew reasonably well (18 to 20 feet tall and 2.5 to 3.5 inches d.b.h. in 8 years), all were on the way out from canker attacks by the fall of 1947 (table 2).

1938 Planting

Twenty-five cuttings each of 15 Oxford Paper hybrids were received from the Northeastern Forest Experiment Station in the spring of 1938. All were set out in the Experimental Nursery, on a good silt loam soil. These were designated as OP 3, 5, 8, 10, 11, 12, 21, 28, 37, 42, 45, 48, 51, 54, and 55 (table 1). Set out also were cuttings of "Henry" poplar (x Populus generosa) which had been obtained from Dr. Syrach Larsen in Denmark. All but one lot did well in the nursery the first year.

Eight lots (OP 5, 8, 28, 37, 45, 51, 54, and "Henry" poplar) which appeared promising, were propagated in the arboretum in 1940 (table 2). In the fall of 1947 all the trees in two lots (OP 5 and 8) and most of those in another (OP 51) had died. Two lots (OP 28 and 54) had fair survival and growth. Three (OP 45, 37, and "Henry" poplar) had good survival and fair growth. However, even this latter group is threatened by canker which is serious in OP 45 and just beginning in the other two lots (table 2).

1939 Planting

Another set of 25 cuttings each, of 15 Oxford Paper (OP) hybrids was received in the spring of 1939 from the Northeastern Forest Experiment Station. These included those designated as OP 1, 2, 4, 6, 9, 14, 16, 18, 19, 27, 29, 31, 32, 34, and 38 (table 1). They were immediately set out in the Experimental Nursery. All grew well there. New cuttings were made of all but OP 9 and planted in the arboretum area in the spring of 1940 along with cuttings made from the hybrids received in 1935 and 1938.

By the fall of 1947 there was a wide range in survival and growth among the various hybrids. Only one hybrid (OP 32) has shown definite promise. It has high survival, good growth and form, and so far has been free of canker and freezing injury. Some of the other lots which have reasonably good survival and growth, either are becoming badly cankered (OP 14, 27, 29, 34), are of undesirable form (OP 18, 19, 27, 29, 30), or otherwise show no ability to make merchantable products (OP 16).

General

Most of the hybrids tested grew from 5 to 7 feet tall the first year in the nursery. They varied in resistance to Melampsora leaf rust and uniformity of development. Second-year growth usually was less--about 3 feet. In plantings on good soil (silt loam) with complete ground preparation, and thorough cultivation the first few years, the best average growth was about three feet per year. While this is better than any species ordinarily planted will do in this locality, it is not as great as many expected. In view of the susceptibility to canker, freezing injuries, and poor form developed, none of the hybrids so far tested can be recommended for planting in the Chippewa National Forest area.

Table 2.--Results of hybrid poplar planted spring of 1940 in Experimental Nursery Arboretum, Chippewa National Forest, Minnesota, examination of October 6, 1947 1/

Designation	Total planted	Alive	Average height	Maximum height	Average d.b.h.
	Number	Percent	Feet	Feet	Inches
O.P. 45	60	62	20	22	2.7
" " 28	60	25	18	20	2.5
" " 51	60	2	9	9	1.2
" " 54	60	30	18	24	3.0
" " 8	60	0	..	..	0
" " 5	60	0	..	..	0
" " 37	60	67	22	26	3.2
"Henry"	60	53	16	20	1.7
97-19	60	58	20	24	2.5
105-1	60	7	20	28	3.0
77-2	60	13	18	24	3.0
?	60	10	8	12	2.5
O.P. 1	60	10	6	10	.7
" " 2	60	15	6	8	.7
" " 4	60	30	7	10	.7
" " 6	60	25	5	8	.3
" " 14	60	65	14	22	1.7
" " 16	60	53	14	21	1.0
" " 18	60	42	11	14	1.2
" " 19	60	62	5	8	.5
" " 27	60	57	10	16	1.0
" " 29	60	82	18	20	2.2
" " 31	60	58	12	16	.7
" " 32	60	95	20	24	1.5
" " 34	60	50	16	18	1.2
" " 38 (?)(last)	60	20	7	10	.7
105-1	200	38	20	30	3.5
77-2	200	38	18	25	3.0
"Henry" 2/	17	100	30	35	4.8

1/ Made by Paul J. Zehngraff.
2/ Planted 1938.

Explanatory Notes to Accompany Table 2

Designation

OP 45	Form	Fairly straight; many limbs; single stems.
	Sprouting	Some stem sprouting, but no root sprouting.
	Cankers	Very bad, both on limbs and trunks.
	Freeze back	None
	Remarks	Mortality primarily due to canker-continuing. Will never produce merchantable products.
OP 28	Form	Poor. Saber formed. Many limbs. Single stems.
	Sprouting	Little stem sprouting.
	Cankers	Very bad.
	Freeze back	Some top freeze back, many dead tops.
	Remarks	Mortality primarily due to cankers, secondly frost. Will never produce merchantable products.
OP 51	Form	Many stemmed bush.
	Sprouting	Early root-sprouting - none left.
	Cankers	- - - -
	Freeze back	From the beginning, new sprouts froze back annually.
	Remarks	Nothing left. Mortality due to frost.
OP 54	Form	Fairly good, but very limby. Several double stems.
	Sprouting	None.
	Cankers	Some cankers on all trees.
	Freeze back	Some. Some dead tops, probably due to canker.
	Remarks	Mortality due to canker and freeze back. Will never produce merchantable products.
OP 8		Nothing left in this lot. Trees reached a d.b.h. of 2 inches but were then killed by canker. No sprouting or sign of life.
OP 5		Didn't survive first year.
OP 37	Form	Excellent, clean smooth bark and stems.
	Sprouting	No root or stem sprouting.
	Cankers	Only a few trees affected so far.
	Freeze back	None.
	Remarks	This is the most promising of the OP lots.
Henry	Form	Good, though limby.
	Sprouting	Considerable.
	Cankers	Just beginning.
	Freeze back	None
	Remarks	Evidently this lot suffered from competition with No. 37. Planting stock made from poor cuttings.
97-19	Form	Very good, though rather limby.
	Sprouting	None.
	Cankers	Very bad.
	Freeze back	None.
	Remarks	Upper half of most trees are now dead due to recent canker attacks. None will survive. (Made from cutting of best original hybrids.)

Designation		
105-1	Form	Excellent.
	Sprouting	None.
	Cankers	Bad.
	Freeze back	None.
	Remarks	This lot resulting from cuttings from best original hybrids looked promising, but canker caused almost complete disappearance.
77-2	Form	Very good.
	Sprouting	None.
	Cankers	All infected.
	Freeze back	None.
	Remarks	This lot resulting from cuttings of one of the best originals is being rapidly killed by canker.
?(missing)	Form	Extremely poor and very limby.
	Sprouting	Considerable.
	Cankers	All badly infected.
	Freeze back	Heavy.
	Remarks	Only few trees survived early freeze back and canker attack. These will soon die from canker. Sprouts have frozen back.
OP 1	Form	Poor, double and triple stems.
	Sprouting	Considerable.
	Cankers	Some evidence.
	Freeze back	Primary cause for mortality.
	Remarks	This lot suffered heavy freeze back from start. Growth was very poor. Not developing trees.
OP 2		Ditto - some canker.
OP 4		Ditto - considerable canker.
OP 6		Ditto - considerable canker.
OP 14	Form	Straight, up to 4 stems per tree.
	Sprouting	Considerable from roots and stem.
	Cankers	Considerable.
	Freeze back	Very little.
	Remarks	Commercial development doubtful. Spotty success, some very good trees.
OP 16	Form	Very straight, many vertical side branches (pyramid).
	Sprouting	Some roots sprouting on injured trees.
	Cankers	None visible.
	Freeze back	None evident.
	Remarks	Recent die-back from tops, many affected.

Designation		
OP 18	Form	Erratic, mostly poor.
	Sprouting	Considerable, stem and root.
	Cankers	Some.
	Freeze back	Considerable, causing poor form.
	Remarks	No future merchantable value, tops dying back.
OP 19	Form	Poor, many stems.
	Sprouting	Considerable, from base.
	Cankers	Little evidence.
	Freeze back	Considerable die-back of tops.
	Remarks	A very poor lot, rapidly dying out.
OP 27	Form	Extremely poor, many stems, limby.
	Sprouting	Considerable from base and stem both.
	Cankers	Considerable, especially on larger trees.
	Freeze back	Considerable die-back of tops, probably freezing.
	Remarks	A very poor lot, rapidly dying out.
OP 29	Form	Extremely poor, crooked, very limby.
	Sprouting	From stems only.
	Cankers	Considerable, many wounds, dead branches and tops.
	Freeze back	None.
	Remarks	No trees will make merchantable products, very bushy.
OP 31	Form	Generally poor, many vertical branches, pyramid.
	Sprouting	Considerable from base.
	Cankers	No evidence.
	Freeze back	None.
	Remarks	Considerable die-back from top. Most dying.
OP 32	Form	Excellent, straight, very few branches.
	Sprouting	None.
	Cankers	None.
	Freeze back	None.
	Remarks	Looks promising so far.
OP 34	Form	Fair.
	Sprouting	None.
	Cankers	Considerable.
	Freeze back	None.
	Remarks	Trees are dying out, cause unknown. Many dead branches and main stems.
OP 38(?)	Form	Fair, but small.
	Sprouting	None.
	Cankers	Some evidence.
	Freeze back	None.
	Remarks	This lot is rapidly dying out.

Designation		
105-1	Form	Excellent.
	Sprouting	None.
	Cankers	Considerable.
	Freeze back	None.
	Remarks	This is from original planting. Canker causing mortality. This lot looked most promising orginally, now understocked.
77-2	Form	Fair, but limby.
	Sprouting	None.
	Cankers	Considerable.
	Freeze back	None.
	Remarks	Second best original lot - high mortality due to canker. Now understocked and many dead tops.
Henry	Form	Very good, some have heavy branches.
	Sprouting	Very little.
	Cankers	Some present - no mortality yet - no dead parts.
	Freeze back	None.
	Remarks	This is original 1938 lot from Denmark. They are more open grown than those planted later, thus they are much better developed both in d.b.h. and height.

North Dakota Tests

1935 Planting

Cuttings of 10 hybrid poplars purchased from the Oxford Paper Company were planted in the spring of 1935 on an experimental area near Denbigh, McHenry County, North Dakota. These were of the same clones as were planted in Minnesota at that time: Nos. 33-2, 33-9, 58-3, 77-2, 96-14, 97-19, 97-28, 97-49, 105-1, and 155-9 (table 1). The soil (Gannett series) of the planting site was a loamy fine sand to a fine sandy loam, overlying a subsoil of fine sand. The permanent water table lay 6 to 10 feet below the soil surface. Originally in prairie sod, the ground was completely prepared, and the trees were weeded and cultivated regularly.

At the end of two growing seasons the best hybrid (33-9) had a survival of 52 percent and an average height of 2 feet (table 3). In comparison some 1-year-old wildling cottonwoods pulled from sand bars along the Missouri River which were planted at the same time had a survival of 84 percent and an average height of 3 feet (range 1 to 6 feet). All the hybrids froze back to the snow line in the winter of 1935-36. The cottonwood did not. Because of continued mortality no later observations were made on these plants.

1937 Plantings

Cuttings of these same hybrids were made and planted in an adjacent small experimental nursery in the spring of 1937. No fertilizers were added to the soil, but the plants were watered occasionally in 1937. Weeding was done as necessary. At the end of two years survival ranged from 0 (96-4) to 68 percent (33-2 and 33-9), and average heights of living trees from $2\frac{1}{2}$ feet (97-28) to $6\frac{1}{2}$ feet (105-1).

General

Although some of the hybrid poplar survived and grew fairly well in the nursery--those planted in the field were inferior to native cottonwood both in survival and growth. Until better hybrids are produced, native cottonwood should be used.

Table 3.--Two-year growth data for Oxford hybrid poplars planted near Denbigh, North Dakota, in spring of 1935

Identification number of hybrid	Survival	Height			Vigor
		Maximum	Minimum	Average	
	Percent	Feet	Feet	Feet	
33-2	14	2.2	1.3	1.7	Fair
33-9	52	3.2	1.2	2.0	Good
58-3	9	2.2	1.3	1.7	Fair
77-2	37	2.3	.7	1.3	Fair
96-4	0	...	...	...	....
97-19	5	1.0	.3	.7	Poor
97-49	3	1.0	.3	.7	Poor
155-9	44	2.2	1.0	1.5	Fair

Michigan Tests

Hybrid poplars were field planted in three localities in lower Michigan, near Wellston in Manistee County, on Big Prairie in Newaygo County, and near Roscommon in Roscommon County.

1938 Plantings

Cuttings of 25 Oxford Paper hybrid poplars, received from the Northeastern Forest Experiment Station, were planted in the Chittenden Nursery, Wellston, Michigan, in the spring of 1938. The hybrids received were numbers OP 1, 2, 3, 4, 6, 7, 10, 11, 21, 28, 29, 32, 33, 37, 39, 41, 42, 44, 46, 47, 48, 50, 51, 52, and 55 (table 1). Survival in the nursery ranged from 42 percent (OP 32) to 98 percent (OP 52 and 55). Average heights ranged from 3.3 feet (OP 32) to 6.3 feet (OP 6 and 11).

Cuttings were made in the fall to provide stored cuttings in the spring of 1939.

1939 Plantings

In the spring of 1939 fresh cuttings, stored cuttings, and rooted cuttings of 14 hybrid poplars (OP 7, 11, 21, 28, 32, 33, 37, 39, 41, 46, 48, 51, 52, and 55) were planted on Big Prairie. The planting site was a bare windswept sand, with a gravelly "desert pavement," droughty and low in soil nutrients. Although all began growth, the fresh and stored cuttings, as well as native cottonwood cuttings, died out by the end of two years. The rooted cuttings were more hardy. After five growing seasons from 0 to 80 percent still survived (table 4) where there was protection either from brush or snow fence. Growth, however, was poor. The best lot averaged only five feet in height under the most favorable conditions. Jack pine 2-0 planted the same time in the same block was much superior in survival and somewhat better in height growth (table 4). Observations four years later showed the jack pine to be much superior on both counts.

Both fresh and stored cuttings of all lots were again planted in the Chittenden Nursery in the spring of 1939. About 85 percent of the trees in all lots survived. There was practically no difference between fresh and stored cuttings; the latter were 3 percent better. Average height at the end of two years ranged from 2 to 9 feet -- most lots were between 6 and 8 feet tall. In some lots the stored cuttings grew distinctly less than the fresh cuttings, but for most of them there was little difference.

A 2-acre cutting nursery was established at the White River CCC Camp near White Cloud, Michigan. Cuttings of all lots were used. Results were similar to those at the Chittenden Nursery.

1940 Plantings

In the spring of 1940 cuttings of 10 poplar hybrids and native cottonwood were planted in an arboretum area near Wellston, Michigan. The soil is a Plainfield loamy sand with a water table 5 to 8 feet from the surface. Included were hybrids OP 6, 11, 21, 29, 32, 37, 39, 41, 44, and 52 (table 1). Four methods of ground preparation were tried: (1) complete spading of the plot, (2) furrowing, (3) thorough scalping, and (4) spading of 3-foot strips. At the end of three years in the field the cottonwood and seven of the hybrid poplars were complete failures. The two lots which had complete ground preparation (OP 6 and 32) and one of those in a spaded strip (OP 29) were the only ones surviving.

Table 4.--Development of hybrid poplar rooted cuttings on Big Prairie, planted spring 1939; measured summer 1943

Hybrid number	Open area		Windrowed brush		Broadcast brush		All conditions	
	Survival	Height	Survival	Height	Survival	Height	Survival	Height
	Pct.	Feet	Pct.	Feet	Pct.	Feet	Pct.	Feet
OP-7	0	..	0	..	0	..	0	..
OP-11	0	..	0	..	0	..	0	..
OP-28	0	..	0	..	0	..	0	..
OP-32	7	1.7	7	1.7	30	2.0	9	1.7
OP-41	10	2.0	66	2.8	80	4.0	62	2.8
OP-44	15	3.0	35	1.7	50	5.0	33	2.4
OP-48	20	2.0	52	2.2	80	4.0	45	2.5
OP-52	25	1.5	78	1.8	75	3.0	59	1.9
All hybrids	6	2.0	32	2.2	38	3.1	24	2.3
Jack pine 2-0	94	2.5	98	2.7	96	3.7	96	3.0

These lots averaged from 3 to 5 feet in height (table 5). This growth is better than that of any other species in the arboretum, although many of them have better survival. None of the other species, however, had the benefit of complete ground preparation. All were planted in furrows. Native aspen sprouts outgrew the hybrid poplars.

Cuttings of 11 hybrids were planted on muck at the edge of a creek valley near Roscommon, Michigan. The water table was 1 to 2 feet from the soil surface. Hybrids OP 1, 3, 6, 10, 28, 41, 46, 47, 50, 51, and 52 were used (table 1). The ground was cleared of vegetation and spaded up. Survival was reasonably good the first few years, but growth was poor. The stems were spindly and froze back each winter. Tamarack on the same site outgrew the hybrids very markedly.

1941 Plantings

In May 1941, a 6-acre planting was made on an open hardwood site, on Roselawn sandy loam, about four miles south of Norwalk in Manistee County. Cuttings of the following hybrids were planted in furrows made with a Killefer plow: OP 1, 2, 3, 4, 6, 7, 10, 11, 21, 28, 29, 32, 33, 37, 39, 41, 42, 44, 46, 47, 48, 50, 51, 52, and 55 (table 1). Native cottonwood cuttings were also planted. At the end of the first year in the field survivals ran from 22 to 90 percent for the various hybrids. Over two-thirds survived 50 percent or better. Heights ranged from 0.7 to 1.3 feet. General observations two years later showed considerable mortality in most lots and poor height growth. Either jack pine or red pine would have done better.

General

Hybrid poplars tested in three general localities in northern lower Michigan gave no promise of success, even equal to the native conifers which might be planted on the same sites. Growth in the nursery was about the same as in northern Minnesota, about six feet the first year and three feet more the second year. In the field, however, survival was poor in most cases and growth, except with complete ground preparation and cultivation, was less than that of native conifers. Deer nipping in some localities might have become serious had the poplars survived better. Melampsora leaf rust occurred on many of the clones. Neither freeze-back nor canker were serious detriments as a rule. However, the latter might have entered the picture if the poplars had developed longer.

Table 5.--Development of hybrid poplar at Wellston arboretum; planted spring 1940

Hybrid number	Ground preparation 1/	Survival		Height	
		1 year	3 years	1 year	3 years
		Percent	Percent	Feet	Feet
OP-6	1	75	73	2.8	4.4
OP-11	2	13	0	.8	...
OP-21	3	36	0	1.0	...
OP-29	4	38	36	1.6	3.2
OP-32	1	73	60	2.6	4.6
OP-37	2	38	0	.8	...
OP-39	4	2	0	1.3	...
OP-41	2	14	0	.6	...
OP-44	2	21	0	.3	...
OP-52	4	20	0	.7	...
Cottonwood cutting	4	8	0	.8	...

1/ 1. Entire plot spaded to 8-inch depth; all competing vegetation removed.
2. Furrowed with Killefer plow.
3. Scalps 3 feet in diameter made; soil within scalps spaded to 8-inch depth.
4. Strips 3 feet wide spaded to 8-inch depth; all competition removed on strips.

Wisconsin Tests

1938 Planting

Cuttings of 25 Oxford Paper hybrid poplars from the Northeastern Forest Experiment Station were planted in the Hayward Nursery, Sawyer County, Wisconsin, in the spring of 1938. As in other nursery trials, all clones made good growth the first year in the nursery. Hybrids included were Nos. OP 1, 2, 3, 5, 6, 7, 9, 10, 11, 12, 21, 28, 29, 32, 37, 39, 41, 42, 45, 46, 49, 51, 52, 54, and 55 (table 1).

1939 Planting

In the spring of 1939 cuttings were made of all lots in the nursery. Some of each lot were planted in two localities: (1) on the Chequamegon National Forest, on a Spencer silt loam, with semi-swamp conditions; (2) on the Nicolet National Forest, on an open sandy outwash plain with a water table 2 to 4 feet below the soil surface.

At the end of the first season survivals ranged from 52 to 92 percent on the silt loam, being somewhat better for cuttings planted in furrows than for those planted in scalps. Average heights in furrows ranged from 1/2 to 1-1/4 feet, and in scalps from 1/3 to 1 foot. On the sandy soil survivals ranged from 48 to 88 percent, and average heights in furrows (the only ground preparation used) ranged from 1/2 to 1-1/2 feet. In both areas growth of the hybrid poplar was decidedly less than that of native aspen sprouts of similar age.

By 1942 the hybrids on the sandy soil (Nicolet National Forest) were a complete failure and the area was replanted with white cedar and spruces. An examination of the silt-loam area in the fall of 1946 disclosed that less than one percent of the cuttings were alive. Their average height was 3.1 feet.

General

Results of hybrid poplar plantings on two Wisconsin national forests were failures. As in Minnesota and Michigan, growth for one year in the nursery was excellent, but field results were disappointing. While early survivals in the field were fairly good, they steadily declined. Growth in the field was poor from the start--much less than that of native aspen sprouts.

Hybrid poplars are also known to have been tested in the Lake States by the Dow Chemical Company, the University of Wisconsin, the University of Minnesota, Michigan State College, and the Kimberly-Clark Corporation.

Tests by Dow Chemical Company

A few years ago, Detroit newspapers gave considerable publicity to the hybrid poplar tests being conducted by the Dow Chemical Company at Midland, Michigan. This aroused a great deal of popular interest in the subject, somewhat prematurely. An authentic report on the Dow Company studies follows[2]:

> We have grown a total of 191 clonal varieties of poplar under many different climatic and soil conditions and most of these studies were comparative with native poplars and other hardy types, such as locust, etc. This material has been obtained from a great many sources as well as our own pollenization work. We also receive reports from 247 cooperative growers to whom we have furnished stock. They are located in many states and other countries.
>
> Our work has been one of selection of possible commercial types, based on disease resistance, growth, habit, cellulose content, survival, etc. Each variety is first tested for two seasons in a nursery, innoculated with canker, and then planted in sample plots if they have the proper qualities.
>
> We have 2,000 acres of sample plots here and plant 12-inch long stored (not calloused) cuttings on four types of soil. We plant each by three methods, namely scalps, furrows, and fitted. We have eliminated all but six varieties and we are propagating these for commercial work. They are comparatively free from disease and insects and under favorable conditions will grow an average of an inch per day in height and 1-1/2 inches in diameter per season. Four of these clones were sent to Professor Kaufert this season.
>
> Most of the hybrids prefer medium light soils on the dry side, altho if the water table is low they will be stunted until the time that they shade the ground and help to conserve moisture. On abandoned farm land we prefer to plow and fit in order to overcome mouse damage the first winter and give the plants a good start. This type of planting (6' spacing) costs $16.20 per acre at the end of the second season, and includes fitting, planting, two cultivations first season, replacing misses and one cultivation the second season. In some cases we have undertrimmed in the spring of the fourth season which seems to help stimulate height growth. Our oldest plantation here of selected material is five years old and will average 8" d.b.h. Reports from the south show much better growth results, as our average growing season is only about 89 days.

2/ Excerpts from a letter of July 16, 1947 by Phelps Vogelsang, then Forester for the Dow Chemical Company.

"Our biggest difficulties come from meadow mice damage during the first winter and especially if grass is present.

Among the hybrids tested by the Dow Chemical Company were those representing crosses 1, 2, 7, 8, 9, 11, 12, 14, 20, 21, 22, 26, 27, 28, 29, 30, and 31 (table 1).

Trials by the Wisconsin Agricultural Experiment Station

Under the direction of Dr. A. J. Riker, the University of Wisconsin has tested Oxford Paper Company hybrid poplars and several native poplar selections in several localities in Wisconsin. The following brief report has been prepared by Professor James E. Kuntz:

"The value of poplars in the land-utilization program has been recognized recently. They grow widely over the state; they are common in reforestation areas; and their growth is more rapid than other trees of economic importance. Poplars now have a variety of uses, including: pulpwood, veneer (for matches and crates), boxboards, fence posts (when treated), excelsior, raw cellulose for industry, as an overstory for white pine, and as a greenleaf mixture in plantings for the improvement of soil fertility and protection against fire.

"The Wisconsin Station (in cooperation with the Wisconsin Conservation Department and the U.S. Department of Agriculture) selected 6 native poplars and secured 25 Oxford Paper Company hybrids from Dr. Schreiner at the Northeast Forest Experiment Station. These hybrids were among the best then available. They included the following numbers: OP 1, 2, 4, 6, 9, 11, 12, 16, 21, 28, 29, 30, 32, 33, 39, 41, 44, 46, 49, 50, 52, 54, 56, and 59. During the past seven years a series of replicated test plantings have been made in eight widely scattered areas in Wisconsin. The ground was plowed and disked; ten-inch, dormant cuttings were spaced 5' by 5'; and the trees were cultivated as needed during the first and second years. Records were kept on survival, growth rate, and disease incidence. As expected, the growth was much better on sites having fertile soil with a high water table than on relatively sandy and dry sites. Some of the selections grew fairly well on the poorer sites for the first season or two, but eventually succumbed to disease.

Some limitations were encountered for the following reasons: (1) winter injury occurred with first season trees, on the tips of succulent shoots, and in frost pockets. However, it was not a limiting factor. (2) Damage from borers, mice, rabbits, and deer in some cases showed differentials with particular numbers. Here again the damage was not generally limiting although some selections were destroyed. (3) Various diseases were encountered, including rust, leaf spots, and canker. No Hypoxylon canker was observed, and only rarely was Septoria seen. On the other hand, Cytospora canker was common and damaging, particularly where the hybrids were growing on anything less than an excellent site. Canker was more severe on some selections than on others. However, none showed a satisfactory degree of resistance.

"Everything considered, the best Oxford Paper Company hybrids were numbers 2, 6, 12, 28, 29, and 54. On good sites they have grown up to 7½ feet the first season and up to 12 to 14 feet the second season. Although these selections have shown low resistance to canker, they could serve as parent material in future crosses because of other desirable characters.

"Among the promising possibilities for future poplar improvement is the selection of outstanding poplars already growing in Wisconsin. These trees already have been subjected to and have withstood many of the unfavorable factors found here. In the spring of 1948 cuttings from over 100 such selections were collected and placed in a nursery planting."

Kimberly-Clark Corporation Tests

Several of the Oxford Paper Company hybrid poplars were field planted in 1938(?) by the Kimberly-Clark Corporation in Wisconsin. According to their Chief Forester, J.B. Millar, the cuttings were planted in scalps on a spruce site. They were given no special care, other than that given regular coniferous planting stock. Growth was poor, and so was survival after a few years. The plantation was a failure.

Tests by the Minnesota Forest Service in Cooperation with the University of Minnesota

In the spring of 1938, the Minnesota Forest Service obtained 25 Oxford Paper Company hybrid poplars (OP 1, 2, 4, 6, 9, 11, 12, 21, 28, 29, 32, 33, 35, 37, 39, 41, 44, 46, 47, 49, 50, 52, 54, 55, and 56) from the Northeastern Forest Experiment Station. Cuttings of each lot were planted on farms in two localities in east-central Minnesota. One was located just west of Wyoming, Minnesota, on a sandy loam soil, and the other about 10 miles farther west. Observations on the first planting only are available.

At the end of two growing seasons in the field, survivals ranged from 27 (OP 32) to 98 percent (OP 6). All but six lots survived 70 percent or better. Average heights ranged from 2.7 feet (OP 1) to 5.7 feet (OP 4, 9, and 28). About half of the lots averaged 5 feet or better.

This plot was re-examined in April 1947, after nine growing seasons in the field. Survivals were considerably lower, but varied a good deal between lots. Several trees of different lots were over 3 inches in d.b.h. and 20 feet in height. The largest tree measured was 32.5 feet tall and 5.3 inches d.b.h. It appeared to belong to clone OP 37, although determination was not certain.

Tests by Michigan State College

In 1888, Dr. J. W. Beal planted eight Russian and four American poplars on sandy land, just south of Grayling, Michigan.[3/] Some of these poplars doubtless were hybrids. The plantings failed within a few years.

More recently the Forestry Department of Michigan State College has tested hybrid poplars in five localities, representing southwestern (Kalamazoo County), central (Ingham and Eaton counties), and northern lower Michigan (Missaukee and Antrim counties), and northeastern upper Michigan (Chippewa County).

According to Professor P. W. Robbins, cuttings of the hybrid Rumford and Oxford poplars (crosses 1 and 22 in table 1) and Northwest poplar were planted during the spring of 1938 in the nursery at East Lansing at a spacing of four feet in the rows and 5 feet between rows. Similar cuttings were also planted in the nursery at the Dunbar Station in upper Michigan.

In May 1941, cuttings of 8 hybrid clones, representing crosses 1, 9, 11, 14, 20, 21, and 27 (table 1) and a form of Lombardy poplar were obtained from the Dow Chemical Company and were planted in the nursery. All these cuttings made good growth in the nursery, often 6 to 7 feet the first season.

Some of the first group of cuttings remained in the nursery for seven years. They suffered from competition because of the close spacing. The best growth was made by Northwest poplar; trees on the outside and ends of rows reached heights of 25 to 27 feet and d.b.h.'s of 4 to 4½ inches, in 7 years.

All three kinds were afflicted with cankers. In the spring of 1942 cuttings of the clones received from the Dow Chemical Company were set out four feet apart in rows six feet apart in a part of the nursery which received no artificial watering. The cuttings grew from 3 to 6 feet the first year and 2 to 3 feet the second year. By the end of the third year the hybrids were 0.75 to 1.5 inches in d.b.h., but cankers were developing on all kinds. After the fourth year the plot had to be eradicated since the area was designated for other use.

Poplars grown in the nursery were used to make cuttings which were field planted in several localities. Those of Northwest, Rumford, and Oxford poplars were set out at the Dunbar Station in 1939, but they died back and grew very slowly. In 1942 cuttings of those clones orginally obtained from the Dow Chemical Company were field planted in several localities.

3/ Information from typewritten report of April 17, 1941, "Survey of Hybrid Poplar Possibilities in Northern Michigan," by Marcus Schaaf, State Forester.

Other

Some older tests were made in the Lake States, but detailed information on them is lacking. About 1904 the Michigan Forestry Commission planted three or four kinds of poplar on the Higgins Lake State Forest.3/ Some of these may have been hybrids. In 1910 a small planting of Carolina poplar (see table 1) was made on the Huron National Forest. All these plantings were on sandy land and all failed within a few years.

EVALUATION OF RESULTS

The hybrid poplars so far planted in the Lake States have given disappointing results in the field. They cannot replace any of the species commonly used under ordinary planting conditions. Best success has come with these practices: (1) complete plowing and fitting of the soil, (2) planting on a good sandy loam or silt loam, (3) cultivation the first year or two.

Although results have varied in different localities, these five Oxford Paper Company hybrids have usually been superior: OP 6, 28, 29, 32, and 54. In northern Minnesota the "Henry" poplar looked better than any of the Oxford hybrids.

FUTURE POSSIBILITIES

Although the Oxford poplar hybrids have not lived up to expectations in the Lake States, work on poplar hybrids and selections should not be dropped. Search should continue for native poplar selections which are superior in growth or wood quality. Such projects are being continued by the University of Wisconsin and University of Minnesota.

Better poplar hybrids should still be sought. Species native to this region should be used in a good share of the crosses. The Oxford hybrids included mostly species foreign to this region, and many of the balsam poplar group. While they have not proven successful, some of them showed sufficiently good growth and form to warrant their use in further breeding work. The promising results in Sweden with hybrids of American and European aspen give a good lead (4). Similar hybrids should be tried in this region. There are a number of other poplar hybrids developed in Europe and Canada, not yet tried in the Lake States, which should be tested. Hybrids of our native cottonwood should also be developed and tested.

Continued and persevering search for better poplar selections and hybrids has a good chance of improving our forest production, through developing faster growing trees which are hardy, disease and insect resistant, of good form, and of high wood quality.

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